

## Application and Study on Knees Joint of Ultrasonography in the Diagnosis and Treatment of Rheumatoid Arthritis

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**Abstract: Objective:** To investigate the value of ultrasound in the diagnosis of rheumatoid arthritis (RA), and to provide objective data for the early diagnosis and treatment of rheumatoid arthritis. **Method:** 64 cases of patients with rheumatoid arthritis, 30 cases of normal control group, were examined by color Doppler ultra-diagnostic instrument, probe frequency 7.5 ~ 15.0MHz. The value and application of ultrasound in patients with RA were observed and compared with the normal group. **Results:** 64 cases of RA patients with knee joint ultrasound images can show clearly the five kinds of pathological changes; 1 knee joint synovial membrane thickening, 2 bursa effusion, 3 sheath thickening, 4.CDFI grade increased 5. Five kinds of pathological changes of bone destruction with the healthy control group were statistically significant ( $P < 0.05$ , respectively); According to the pathological changes of the knee joint ultrasound images and the corresponding clinical manifestations of the knee, can be more clearly the RA induced knee lesions were divided into mild (I degrees), moderate (II degrees) and severe (III degrees). And also according to the pathological changes of the knee joint ultrasound images, the severity of the pathological changes of RA patients was found to be independent of the age of the patients, and there was a significant correlation with the history of the patients, and the correlation coefficient was close to 1. **Conclusion:** 1) The routine assistant diagnosis in RA with X-ray would be replaced with ultrasound; 2) the correlation between the five pathological changes and pathological changes of the knee joint in patients with ultrasound RA and the length of history, and according to the clinical manifestations of RA patients with ultrasound images of the knee joint and the corresponding knee, the pathological changes of knee joint were divided into mild grade (I degree), moderate grade (II degree) and severe grade (III degree), in order to clear and convenient for RA clinical diagnosis, treatment and research. 3) To define the change of the knee joint of RA patients with 1-16 and the characteristics of the positive correlation with the history of RA. At the same time, it also suggested that there is no obvious clinical effect on RA in the diagnosis and treatment, to strengthen the pathogenesis, diagnosis and treatment of RA is still the goal and direction of the efforts of governments and medical science and technology personnel all over the world.

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**Keywords:** ultrasonic diagnosis; rheumatoid arthritis, RA; Autoimmune disease; Knee joint disease; musculoskeletal ultrasound.

### 1. Introduction :

Rheumatoid arthritis (RA) is an autoimmune disease of chronic systemic inflammation, which is the main target of the synovial membrane, and its damage to the whole body, especially the damage to the knee joint, still cannot make the early diagnosis and treatment [1-5]. For nearly a century, the discovery and application of X-Ray in the early diagnosis of RN induced bone and joint damage has improved, but only in the joint bone damage, X-ray is possible to diagnose the disease of the bone joint. However, RA, as an autoimmune disease, is an unknown cause of immune response to repeated attacks lead to soft tissue lesions around the joint, X-ray, as well as in the past few

decades, MRI and CT have focused on the detection of bone lesions and tissue solid lesions. Therefore, it is necessary to choose a suitable machine for the diagnosis of RA induced joint soft tissue lesions [6-12]. In recent years, it is a new attempt to use ultrasound in the diagnosis of joint disease [13-15]; This study is based on the analysis of 64 cases of RA patients with a comprehensive system of ultrasonic images, objective to investigate the value of ultrasound in the diagnosis of rheumatoid arthritis, and to provide objective data for the early diagnosis and treatment of rheumatoid arthritis.

## 2. Material and Methods :

**2.1. Instruments:** using the ultrasound diagnostic apparatus, the probe frequency is 7.5 ~ 15.0MHz.

**2.2. Object of study:** 64 cases of rheumatoid arthritis were selected from October 2014 to October 2015 in the 2<sup>nd</sup> affiliated hospital of Zhengzhou University, Henan State, China. Among them, 25 males and 39 females, aged from 25 to 48 years old, average (37.6 + 4.2) years old, the course of disease was 1 to 16 years, average (8.57 + 4.45) years (Table-1) . Normal control group of 30 volunteers, no abnormalities and joint pain history, RA family history, before the examination were inspected by consent, there were 12 males and 18 females, aged 27-64 years old.

**2.3. Method:** Record statistical course of disease, clinical symptoms of joint pain and function is normal for the standard; Ultrasound of knee joint with supine or sitting, knee flexion 30-60, multi section observation

of synovial capsule, synovial membrane, tendon, ligament and bone continuity. The prone position, knee extension: the use of ultrasound in superficial probe. Longitudinal section and transverse section perpendicular to the three section of the examination of joint, observation of joint and joint subsidiary structure. Measurement in mm as a unit; The MDFI grading of blood flow signal was used as the criterion for the pathological changes of the inflammatory congestion [4]. According to the literature [16-20], five kinds of pathological changes of ultrasonic images of the knee joint were observed and recorded: 1 synovial membrane thickening, 2 bursa fluid effusion, 3 tendon sheath thickening, 4. CDFI grade, 5 bone destruction. And the pathological changes of the five kinds of ultrasonic images of the knee joint were analyzed statistically, as a result of the study [21-27].

Table 1. 64 RA Patients and 30 Normal Control Information

Group*	M	F	Mean Age	Average of Illness History	Ultrasonic Detecting Position
64 RA	25	39	37.60±4.20	8.57±4.45	Knees Joints
30 NC	12	18	46.43±11.3	0.00	

RA- rheumatoid arthritis group, NC-Normal Control group.

**2.4.** Statistical analysis of all data uses SPSS 21.0. Using SPSS11.0 statistical software, data using mean standard deviation ( $\bar{X} \pm S$ ), percentage (%) and correlation coefficient representation and analysis Comparison between groups was analyzed by one-way analysis of variance or *t* test and chi-square test, *P* values of less than 0.05 were considered statistically significant [28-32].

## 3. Result:

**3.1.** Ultrasound image diagnosis of RA patients with pathological changes of knee joint, and the incidence of five kinds of pathological changes in the ultrasound images of 64 cases of RA patients with knee arthritis;

The diagnosis of pathological changes of the knee joint in RA patients is shown in figure 1, 2. The incidence of five kinds of pathological changes in 64 cases of RA patients with knee arthritis were respectively (Table-2); 1) the synovial membrane thickness of the knee joint in 64 cases, accounting for 87.50% of the 64 cases of RA patients, 2) 50 cases of synovial fluid effusion, accounting for 75% of the 64

cases of RA patients, 3) tendon sheath thickening in 29 cases, accounting for 45.31% RA patients, 4) bone destruction in 4 cases, accounting for 23.44% cases of RA patients, (5) CDFI in 50 cases, accounting for 76.92% in 64 patients with RA; 64 cases of RA patients with knee arthritis in ultrasound images of the incidence of five kinds of pathological changes compared with the normal control group, all showed significant statistical significance, respectively,  $P < 0.01$ ,  $P < 0.05$ ,  $P < 0.01$ ,  $P < 0.01$ ,  $P < 0.01$  (Figure -3).

**3.2.** Comparison of the correlation between pathological changes and clinical symptoms in patients with RA:

**3.2.1.** The pathological change trend of knee joint was consistent with the severity of clinical symptoms in patients with RA ;

According to the pathological features and the function of the knee joint in 56/64 patients with RA, the groups were divided into three groups; Group A is 8 case with the Normal function of knee joint;

Table 2. Incidence rate of five kinds of pathological changes in 64 cases of RA with knee osteoarthritis

Ultrasound Examination	Synovial Membrane Thickness	Bursa Fluid Effusion	Tendon Sheath Thickness	Destruction Bone	CDFI
64 RA	56/64	50/64	29/64	15/64	50/64
Percent (%)	87.50	78.13	45.31	23.44	78.13

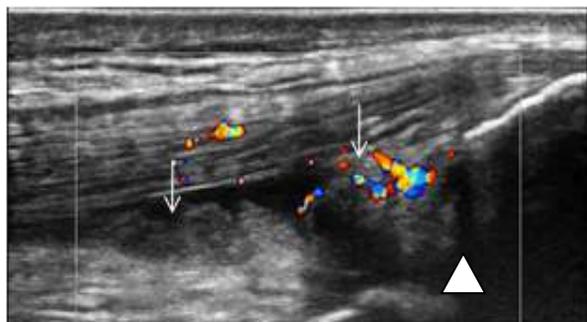


Figure 1. RA patients with different knee joint ultrasound images A: Knee joint for longitudinal sonogram. The white triangle in the figure refers to the non echo area for the bursa Fluid effusion, the white arrow refers to the shape of the low echo of the thickening of the synovial membrane, CDFI showed that the distribution area of the blood flow signal was 1/2 of the thickened synovial zone, and CDFI was 2.

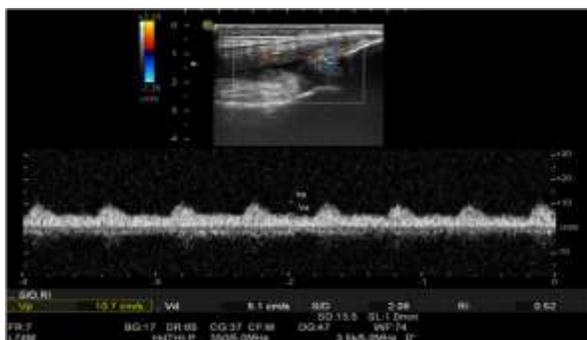
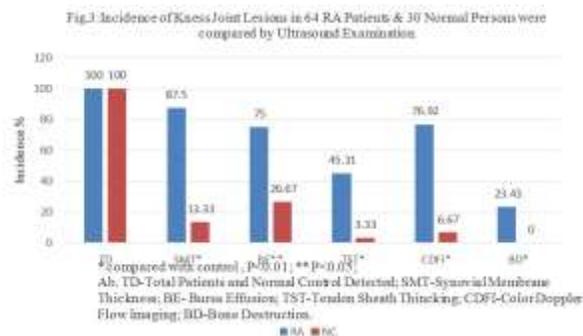


Figure 1. RA patients with different knee joint ultrasound images B: For the PW image of the Knee joint thickening synovial, the spectrum of the low velocity and low resistance blood Flow signal can be detected as VP: 11cm/s, RI: 0.52.



Group B is 27 cases of knee joint; And Group C is 21 cases of abnormal knee function group(Table-3). The Comparison of A, B, C three groups of ultrasound images of pathological changes can be clearly seen; (1) there is no difference in the average age of the three groups of RA patients; The group C with 12.47 years of mean RA illness history is higher than the group A with 4.50 years of mean RA illness history, C and A group compared to the obvious statistical difference (P<0.01) (table-3).

**Table3.** 56 RA knee synovial thickening and CDFI Grading with increased patient history and increased correlation

Group#	Case	Mean Age (year)	Mean History	Illness	Mean Thickness of Synovial Membrane	Mean CDFI Classification
A	8	34.63±5.85	4.5±2.45		1.42±0.64	0.38±0.74
B	27	37.37±7.57	6.74±3.87		2.90±0.55	1.81±0.48
C	21	36.76±6.4	12.47±2.40*		4.05±0.36*	2.90±0.30*

#Group A-Norma Knees Function; Group B- Knee Joint Pain; Group C - Knee Joint Dysfunction.

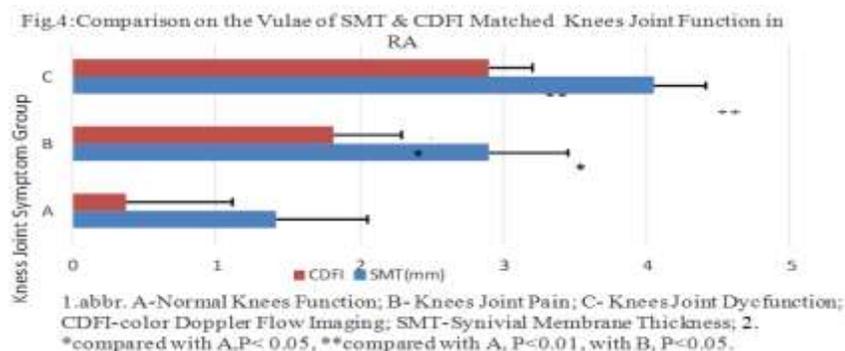
\*Group C was compared with Group A, P <0.05 respectively.

**3.2.2.** The comparison between the knee joint function and Synovial Membrane Thickness and CDFI grading in patients with RA [28-32].

Comparison on the A, B, C three groups of RA patients with knee function changes and ultrasound images of the thickness of synovial thickening: the function of the knee joint function normal (A) group synovial thickness is less than 1.5 mm, knee joint pain (B) group of synovial thickening thickness greater than 1.5 mm less than 3 mm, the thickness of the synovial thickening in the knee joint function (C) group was greater than 3 mm, group C compared

with group B and group A were statistically different (P<0.05,P< 0.01 respectively) (Figure 4);

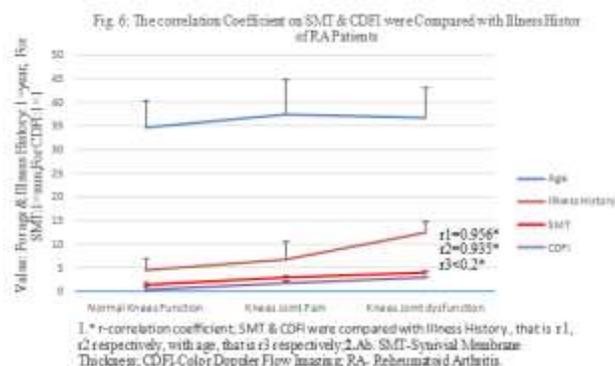
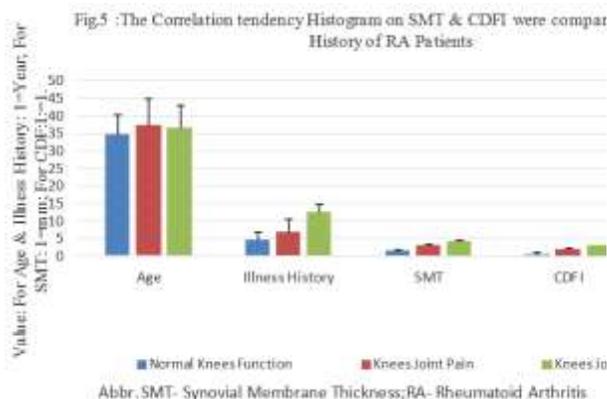
A, B, C three groups of RA patients with knee function and ultrasound images CDFI classification of the degree of comparison: the knee function of the normal (A) group CDFI grading is less than 1, knee joint pain (B) group CDFI grade is greater than 1 and less than 2; CDFI grading of knee joint dysfunction (C) group was greater than 2 and less than 3, and Group C compared with group B and group A were statistically different (P<0.05,P< 0.01 respectively) (Figure 4);



3.2.3. Ultrasound images showed that the thickness of synovial thickening and the degree of CDFI were increased with the illness history of RA patients, which showed a significant positive correlation [33-35]

With the extension of RA's history, ultrasound image on knee joint showed; The severity of the symptoms of the three groups (from A to B to C group) was significantly correlated with the degree of the corresponding ultrasonic synovial thickness and the degree of CDFI classification, and showed a

significant correlation with the trend histogram (Figure 5). At the same time, by comparing the correlation can be seen, The synovial membrane thickness and CDFI grading increasing were not correlation with the age of the patients with RA (Figure 6). However, the thickness of the synovial thickening and the degree of CDFI classification were a significant correlation to be compared with the illness history of the patients with RA, the correlation coefficient is close to 1 ( $r=0.956$ ,  $r=0.935$ ) (Figure 6).



4 Discussion:

4.1. The Value of clinical application of ultrasonography in the diagnosis and treatment of RA; the past century, the main auxiliary equipment used for the examination of human bone diseases is x-ray[1], however, X-ray cannot make an early diagnosis in treatment of RA, because the X-ray is through the application of 0.01-1 (Å), the short wavelength penetrating effect of invisible light, visible light and solid design principle, for human bone lesions or soft tissue hardening inspection of medical equipment. RA, however, is a chronic systemic inflammatory autoimmune disease, which is the main target of the synovial membrane, in the absence of bone erosion and destruction before, is to synovial cell hyperplasia, inflammatory cell

infiltration, synovial Yi formation, pathological changes of [6] recurrent joint inflammation of soft tissue, thus, when X-ray was found, more than the knee joint bone injury, and the rapid development of functional abnormalities [2]. In recent years, because there is no equipment to make an early diagnosis on the soft tissue pathological changes in the earl of RA, the diagnosis, treatment, and research of the knee joint caused by RA is in a state of cessation. The research and development of ultrasound examination in the pathological changes of soft tissue in the last twenty years, it has made a new progress in the detection of recurrent arthritis of the knee joint caused by RA. The pathological changes of 64 cases of RA in 56 patients with RA were showed the characteristic of five kinds of pathologic features

(Figure 1,2,3); 1 (synovial membrane thickening, 2 ( bursa Fluid effusion, 3 (tendon sheath thickening, 4 (bone destruction, 5 (CDFI grading. Five kinds of pathological features of the ultrasonic image of the knee joint, that can be used as the diagnosis and treatment of RA knee joint pathological changes standard. In addition, RA is an autoimmune disease of chronic systemic inflammation, The pathological changes of the knee joint are mainly caused by repeated inflammation, which leads to the chronic inflammation of the soft tissue, Therefore, ultrasound can be used instead of X-ray as a clinical assistant diagnosis of RA patients with RA, in order to facilitate the treatment and research progress [36-40].

**4.2.** Named "RA knee joint ultrasound three degree grading standard", convenient for clinical RA diagnosis, treatment and research;

The research results showed that according to the ultrasound image in knee joint synovial thickening and thickness of CDFI grade, RA can be divided into objective the mild (I), moderate (II), severe (III) diagnostic criteria as the three grading; At present, there is not any report on the diagnostic criteria for RA knee joint images as a diagnostic criterion for clinical diagnosis of RA[41,42], this result would be named "RA knee ultrasound three degree grading standard", that is convenient for clinical RA diagnosis, treatment and Research (Figure 3,4). "RA knee joint ultrasound three degree classification" specific content is below;

I Degree ( mild )synovial thickening: when the thickness is less than 1.5 mm, or / and CDFI score less than 1, corresponding to the clinical manifestation of knee joint function in patients with normal or occasionally slight discomfort;

II degree (moderate): when the synovial thickness is greater than 1.5 mm less than 3 mm, or / and CDFI grading is greater than 1, less than 2, the corresponding clinical table is patients with knee pain or severe discomfort clinical manifestations;

III degree (severe): when the synovial thickness greater than 3 mm or / and CDFI grading is greater than 2, less than 3, the corresponding clinical table is the patient can appear different degree of knee joint dysfunction or severe pain affect quality of life.

**4.3.** The clinical value and application of the changes of ultrasound images of the knee joint in RA patients and the positive correlation with RA;

The study of 1-16 patients with RA history of the knee joint ultrasound image changes show, regardless of whether the patient had received any treatment, there was a significant positive correlation between the thickness of synovial thickening and the degree of CDFI and the incidence

of RA in the ultrasound images of the knee joint, and the correlation coefficient was close to 1, but there was no correlation with age ( $R < 0.2$  Figure 5). These findings suggest that the thickness of the synovial thickening and the degree of CDFI classification in the ultrasound images of the knee can be used with clinical, as one of the objective evaluation indexes of RA diagnosis, treatment and research, it will certainly be helpful for the rapid development of RA's research, diagnosis and treatment

4.4. At present, the diagnosis and treatment of RA are in a stop condition, prompting governments and medical science and technology personnel should pay attention to the research of RA diagnosis and treatment [43-45];

Clinical practice has proved that <sup>[10]</sup>, all RA patients are in a different diagnosis and treatment, but due to the limitations of the development of medical technology, there is no effective treatment of drugs and measures <sup>[11]</sup>. In this study, the results of ultrasound images of the knee joint in RA patients with 56/64 are consistent with the research reports. Therefore, it is suggested that governments and medical technicians should pay attention to the research of RA in the diagnosis and treatment of [46-53].

## 5. Conclusion:

**5.1.** Ultrasound can be clearly diagnosed RA patients with different stages of the pathological changes of the knee may be recommended to confirm the clinical trial, with ultrasound in place of X-ray as a diagnostic and treatment of RA patients with diagnostic criteria for the diagnosis and treatment.

**5.2.** Five kinds of pathological features of RA knee joint ultrasound examination were made clear. 1) synovial membrane thickening, 2) bursa Fluid effusion, 3) tendon sheath thickening, 4) bone destruction, 5) CDFI grading. Can be recommended for clinical trials confirmed that the five kinds of pathological features as the RA clinical diagnostic criteria and the evaluation of therapeutic effects.

**5.3.** According to the results of the study, named "RA knee joint ultrasound three degree grading standard", convenient for clinical RA diagnosis, treatment and research.

**5.4.** The pathological changes of the ultrasound images of the knee joint in RA patients were significantly correlated with the history of the disease, and there was no correlation with the age.

**5.5.** 1-16 year history of RA patients with ultrasound image changes in the knee and the history of RA into a positive correlation of the characteristics of the changes; that point out, at present, there is no obvious clinical effect on the treatment of RA, to strengthen the pathogenesis, diagnosis and treatment of RA is

still the goal and direction of national governments and medical science and technology personnel in the century.

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